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PLYWOOD LAMINATE HAVING IMPROVED DIMENSIONAL STABILITY AND RESISTANCE TO WARPING AND DELAMINATION

Technical Field

[0001] The present invention is related to plywood structures comprising a plurality of wood veneer plies and decorative plywood laminates, and particularly to plywood laminates and decorative laminates having improved dimensional stability and resistance to warping and delamination. Further, the invention is directed to such decorative laminates having a click-lock or tongue and groove edge configuration.

Background of the Invention

[0002] Plywood structures are well known in the art. They are composed of layers or plies of wood veneer with adjacent plies bonded with an adhesive. Decorative plywood laminates include a decorative ply adhered to a plywood substrate. The ply of the substrate opposite or distal the decorative ply is known as the back ply. One of the limitations of the prior art plywood is its relatively poor dimensional stability, which results in warping and cracking.

[0003] Those skilled in the art have tried to improve the dimensional stability of plywood by various means. Most commonly the direction of the grain of adjacent plies have been aligned substantially perpendicular to each other. The plies having grain perpendicular to the grain of the decorative ply being crossband plies. Typically, the grain of the decorative veneer or ply is parallel to the lengthwise edge of the veneer.

[0004] Improved dimensional stability can be obtained by increasing the number of plies or decreasing the thickness of the plies. For a given desired thickness, the thinner the plies, the more plies comprise the plywood and the stronger and more stable the plywood.

[0005] Most plywood is made using the same species of wood. However, Hsu U.S. Patent No. 5,040,582 discloses a multi species laminated veneer lumber (a specialty plywood used for lumber manufacture), as well as laminated veneer lumber made from the combination of hardwoods and softwoods. Hsu notes the difference in shrinkage and expansion between the different wood species, particularly between high and low density wood species. He teaches that

the species sequence from face to core must be identical or very similar on either side of the center ply when an odd number of plies are used or on either side of the center line when an even number of plies are used.

[0006] Walser et al. U.S. Patent No. 5,234,747 teaches a symmetrical lay-up of, from top to bottom, multiple plies of a low density, 6% to 15% moisture content spruce, multiple plies of a high density, less than 5% moisture content Douglas fir, and multiple plies of a low density, 6% to 15% moisture content spruce.

[0007] Polymer laminates comprising phenolic resin-impregnated paper, such as taught in Nelson et al. U.S. Patent No. 5,989,668 have a dimensional stability superior to that of plywood. The dimensional stability of the resin-impregnated laminates permit the use of click-lock edge structures such as disclosed in Pervan U.S. Patent No. 6,023,907 and Morian et al. U.S. Patent No. 6,006,486.

[0008] As such, a need exists for a plywood laminate having improved stability and resistance to warping and delamination, particularly one that uses less expensive wood plies. Such a plywood laminate would permit the use of click-lock edge structures.

Summary of the Invention

[0009] It is therefore, an object of the present invention to provide a plywood laminate including higher quality wood plies, lower quality wood plys, and an adhesive. The higher quality wood plies may be better than ANSI/HPVA HP-1-2000 veneer grade C and the lower quality plies may be no greater than ANSI/HPVA HP-1-2000 veneer grade C. The higher quality wood plies may be a hardwood and the lower quality plies may be a lower quality hardwood or a softwood.

[0010] It is also an object of the present invention to provide a plywood laminate having plies of at least two different qualities in which the effects of the anisotropic nature of wood is minimized in the laminate while lay-up of the plies is structurally asymmetrical.

[0011] It is a further object of the present invention to provide a plywood laminate in which the plies may have different thicknesses.

[0012] It is another object of the present invention to provide a plywood laminate in which the moisture content is controlled to improve dimensional stability. The moisture content may be controlled between 6% and 8%.

[0013] A still further object of the present invention to provide a decorative plywood laminate including a decorative ply and the plywood laminate of the present invention.

[0014] Yet another object of the present invention to provide a decorative plywood laminate having a click-lock edge configuration, particularly in which at least one adhesive layer is interposed between the upper surface and the lower surface of the tongue. This permits the use of the decorative plywood laminates in a floating floor, in which the segmented floor pieces are not glued to the subfloor.

Brief Description of the Drawings

[0015] Figure 1 is cross-sectional view of a first embodiment of the invention with portions removed to more clearly show the features of the invention.

[0016] Figure 2 is cross-sectional view of a second embodiment of the invention with portions removed to more clearly show the features of the invention.

Detailed Description of the Invention

[0017] Segmented floors with click-lock edge configurations are currently manufactured only using non-wood or polymer resin-impregnated laminates or similar structural substrates since the click-lock system requires substrates with good strength and minimal anisotropic differences, which yield good dimensional stability. Good dimensional stability is of increased importance in segmented floors that are installed without adhesively bonding the floor to the subfloor. Segmented plywood floors of the prior art, which have tongue and groove edge configurations and float on the subfloor, expand and contract under varying humidity conditions, causing warping of the segmented pieces. Any warping of the segmented pieces can appear as raised spots in the floor.

[0018] Wood materials are preferred in general as flooring substrates over the polymer resin-impregnated laminates, but have lower strength and dimensional stability. Due to the anisotropic nature of wood, plywood structures have been considered unsuitable in

manufacturing segmented floors with the click-lock edge configuration. Such edge configurations require intricate cutting and the anisotropic properties of the wood tend to cause the tongues to break during use.

[0019] The plywood structure of the present invention has sufficient strength and dimensional stability for the click-lock edge configuration to be efficiently manufactured and used. The resultant segmented pieces also have sufficient dimensional stability and mechanical performance properties to deter warping and delamination.

[0020] The present inventors have developed a plywood laminate that has sufficient strength and dimensional stability to permit click-lock edge configurations while minimizing the number of higher quality plies, thereby minimizing the cost of the decorative plywood laminate. The decorative plywood laminate 1 of the present invention comprise a decorative ply 2, such as oak or other hardwood, and a plywood laminate substrate 3. The plywood laminate substrate 3 comprises at least two pluralities of plies 4 and 5. Plies 4 are of quality higher than the quality of plies 5. The plies are adhered together with an adhesive, which forms an adhesive layer 7 interposed between the plies.

[0021] For example, plies 4 may be a hardwood species and plies 5 may be a softwood or lower quality hardwood species. In another embodiment, plies 4 have a veneer grade of greater than ANSI/HPVA HP-1-2000 veneer grade C and the plurality of lower grade plies have a veneer grade of no greater than ANSI/HPVA HP-1-2000 veneer grade C.

[0022] As shown in Figure 1, in one embodiment a higher quality ply 4 is adjacent the decorative ply 2. The third ply from the decorative ply and the bottom ply, which is distal the decorative ply, are also higher quality plies 4. In the embodiment shown in Figure 2, the higher quality plies 4 are adjacent the decorative ply 2, fourth ply from the decorative ply and the bottom ply, which is distal the decorative ply.

[0023] As in prior art plywood laminates, the dimensional stability is improved by having the grain of adjacent plies perpendicular to each other. In the present invention, if there is an even number of plies in the substrate, the ply adjacent the decorative ply is a crossband ply having its grain perpendicular to the grain of the decorative ply, and the bottom, or distal, ply has a grain parallel to the grain of the decorative ply. In this embodiment, the grains of adjacent plies are perpendicular as in the prior art. However, if there is an odd number of plies in the substrate, the ply adjacent the decorative ply should have its grain perpendicular to the grain of

the decorative ply, and the bottom, or distal, ply has a grain parallel to the grain of the decorative ply. Therefore, two adjacent inner plies have grain in the same direction.

[0024] In a one embodiment, the top and bottom plies of the substrate are chosen from the plurality of higher quality plies. At least two adjacent interior plies are chosen from the plurality of lower quality plies. If there are an even number of plies in the substrate and since the grain of adjacent plies are perpendicular to each other, the grain of the adjacent lower quality plies, such as shown in the figures, are perpendicular to each other. Further, the plurality of higher quality plies typically have at least one ply with grain parallel to the grain of the decorative ply and at least one ply with grain perpendicular to the grain of the decorative ply.

[0025] While not limited to decorative plywood laminates having a tongue and groove, or click-lock edge configuration, the present invention has certain advantages in such structures. By using lower quality plies, the overall cost of the laminate is reduced, however adequate dimensional stability and resistance to warping is obtained. Furthermore, to ensure adequate strength of the tongue, at least one of the plies forming the tongue is chosen from the plurality of higher quality plies. As shown in Figures 1 and 2, if either the third or fourth ply from the bottom of the substrate is a higher quality ply, the tongue 6 comprises a higher quality ply.

[0026] It is also noted, by choosing the proper thickness of the plies, the tongue comprises portions of at least two plies. Again, since the grains of adjacent plies are perpendicular to each other, the strength of the tongue is increased. Further, the horizontal surfaces of the edge configurations do not coincide with the adhesive layer between the plies. Since the adhesive layer is intact, the two perpendicular layers in the tongue minimize the amount of chipping and checking.

[0027] The invention is not limited to a substrate having 6 plies or even a substrate having an even number of plies. There should be at least 4 plies forming the laminate substrate. The maximum number is limited by economics. However, the greater the number of plies per given thickness, the greater is the strength and stability, and the anisotropic nature of the wood is minimized.

[0028] Since the decorative ply is a higher quality ply, if the ply of the substrate adjacent the decorative ply is a higher quality ply, it can be of a quality less than the quality of the other higher quality plies in the substrate. For example, the ply adjacent to decorative ply can have a veneer grade of ANSI/HPVA HP-1-2000 veneer grade C+, while the remaining

higher quality plies can have a veneer grade of ANSI/HPVA HP-1-2000 veneer grade B or greater.

[0029] In some embodiments, the higher quality and lower quality plies are hardwoods selected from Shorea spp., and more particularly Meranti or Lauan. These hardwoods are relative inexpensive and the grain of the Meranti wood is straighter than many hardwoods, thereby lowering the tendency of warping. The density of the wood is preferably between about 400 and about 600kg/m^3.

[0030] The adhesive should be an exterior grade, high quality structural adhesive. These adhesives, once cured, are water resistant and not permeable to moisture. The thickness of the adhesive layer between the plies is typically a minimum of 6 mils. In some embodiments the adhesive is phenol resin or amine resin adhesive. In some embodiments, aqueous-based UV-curable urethane adhesives, such as melamine-urethane-formaldehyde resins, are preferred to adhere the decorative ply to the substrate. In some embodiments the adhesive is a phenol-formaldehyde resin, a water and boil proof glue that passes British Standard 6566-1985 WPB, i.e. the 72-hour boiled test samples should show 40% or higher wood failure values at the broken glue lines for at least 60% of the sample set.

[0031] The thickness of the plies is typically between about 0.03 inches to about 0.07 inches (between about 0.75 and about 1.75 mm). Thinner plies are more difficult to cut and thicker plies yield laminate that are less stable for a given thickness. To make such problems less likely, the thickness of the plies can be maintained between about 0.04 inch and about 0.063 inch (between about 1.0 mm and about 1.6 mm).

[0032] It has been found that the bottom or distal ply may be thinner than the other plies. In one embodiment, the other plies are between about 0.06 inch and about 0.063 inch (between about 1.5 mm and about 1.6 mm) and the bottom ply is about 0.04 inch (about 1 mm).

[0033] To improve dimensional stability and good bonding, the moisture content of the decorative plies, the substrate plywood laminate and the finished decorative laminate is controlled during manufacture and shipment. The moisture content is maintained between about 6% and about 8%, tested according to ASTM D4442-92. Otherwise, the wood will absorb or expel water resulting in expansion and warping.

[0034] To assist in the control of moisture content of the finished decorative laminates, the tongues and grooves are coated with a high quality water repellent, lubricating coating and the back face is coated with a sealer coat. The back face, tongues and groove may also be coated with a fungicide.

[0035] The effectiveness of the coatings is determined by measuring the average moisture content of a coated decorative plywood laminate and an uncoated decorative plywood laminate, placing them in a constant humidity chamber, exposing them to a 90% relative humidity environment at 80°F for 7 days, and then measuring the average moisture content. The increases in the average moisture content of the coated and uncoated laminates are compared. It is desired that the increase in the average moisture content of the coated laminate be less than 20% of the increase in the average moisture content of the uncoated laminate (80% effectiveness), and preferably less than 10% (90% effectiveness).

[0036] The dimensional stability of a plywood is dependant, among other properties, on the grain direction of the plies being accurately parallel or perpendicular to the longitudinal direction of the plywood. The grain direction is identified by visual inspection. It is the direction parallel to the vessels and rays of the wood, which for most hardwoods such as lauan appear as straight, short streaks on the finished veneer surfaces. The grain direction is measured by using a ruler to draw a line parallel to the short lines, and determining how much it diverges from the edge of the plywood laminate. The grain direction is reported as a fraction, such as 1/48, i.e. there is a one inch deviation in every 48 inches of length. It is desirable to have a grain direction of 1/48 or less, preferably 1/96 or less.

[0037] Because of the dimensional stability of the substrate plywood, it can be used in another embodiment in which a melamine overlay, such as a polymer resin impregnated layer described in the Nelson et al. '668 patent, is adhered to the substrate. The melamine overlay is then printed by a direct printing method known in the art.